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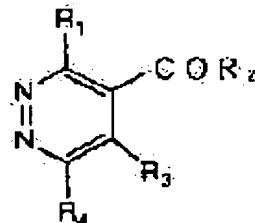
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(54) INTERLEUKIN-1 BETA CONVERSION ENZYME INHIBITOR

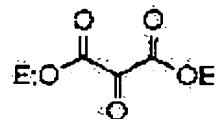
(57)Abstract:

PURPOSE: To obtain a new pyridazine compound capable of inhibiting interleukin-1 β protease activity and useful for treating an inflammatory disease, an immune system disease or a cancer.

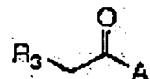
CONSTITUTION: A compound of formula I [R1 is a halogen or an oxygen-bound leaving group; R2 is OR5, N (R5)R6 (R5 and R6 are each H, a lower alkyl, aryl, etc.); R3 is H or an alkyl; R4 is H, a (substituted) aryl, an alkyl, etc.; (m)=1-6; (n)=2-6], e.g. 3-chloro-4-carboxamido-6-(4-pyridyl)pyridazine. A compound of formula I is obtained as follows: a compound of formula II is made to react with a compound of formula III; the product is treated with hydrazine in ethanol for reduction to obtain a 6-aryl-3-hydroxypyridazine; this compound is saponified with an alkali aqueous solution followed by neutralization; the product is refluxed in the presence of POCl3; etc.



I



II



III

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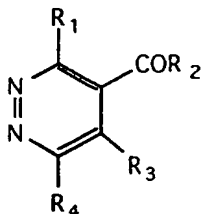
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64 Pyridazines as interleukin-1beta converting enzyme inhibitors.

57 Disclosed are compounds of the formula (I) and pharmaceutically acceptable salts thereof:



(I)

wherein

R₁ is halogen, oxygen linked leaving group including aromatic ether, aromatic ester, alkyl sulfonate, aryl sulfonate, alkyl phosphonate, aryl phosphonate, alkyl phosphate or aryl phosphate;

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R_2 is OR_5 , $NH(CHR_5)_m-COOR_5$, $NH(CHR_5)_mCON(R_5)R_6$, $N(R_5)R_6$ or $NH(CHR_5)_nOH$;

R_3 is H or alkyl;

R_4 is H, substituted or unsubstituted aryl, heteroaryl or alkyl;

R_5 and R_6 are independently H, lower alkyl, aryl, heteroaryl, aralkyl, heteroaralkyl or lower cycloalkyl;

$m = 1-6$; and

$n = 2-6$.

pharmaceutical compositions containing the compounds; and a method for inhibiting interleukin- 1β protease activity in a mammal utilizing the compounds and compositions.

This invention relates to a series of novel pyridazine analogs which exhibit selective inhibition of interleukin-1 β -converting enzyme, to compositions containing the novel pyridazine analogs and methods for therapeutic utility. More particularly, the interleukin-1 β -converting enzyme inhibitors described in this invention comprise novel pyridazine analogs which possess particular utility in the treatment of inflammatory, immune-based diseases and cancer.

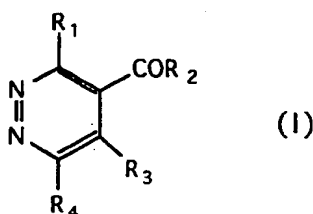
Interleukin-1 β protease (also known as interleukin-1 β -converting enzyme or ICE) is the enzyme responsible for processing of the biologically inactive 31 kD precursor IL-1 β to the biologically active 17 kD form (Kostura, M.J.; Tocci, M.J.; Limjuco, G.; Chin, J.; Cameron, P.; Hillman, A.G.; Chartrain, N.A.; Schmidt, J.A. *Proc. Nat. Acad. Sci.*, 1989, 86, 5227-5231 and Black, R.A.; Kronheim, S.R.; Sleath, P.R. *FEBS Let.*, 1989, 247, 386-391). In addition to acting as one of the body's early responses to injury and infection, IL-1 β has also been proposed to act as a mediator of a wide variety of diseases, including rheumatoid arthritis, osteoarthritis, inflammatory bowel disease, sepsis, and acute and chronic myelogenous leukemia (Dinarelo, C.A.; Wolff, S.M., *New Engl. J. Med.*, 1993, 328, 106). The naturally occurring IL-1 β receptor antagonist has been used to demonstrate the intermediacy of IL-1 β in a number of human diseases and animal models (Hannum, C.H.; Wilcox, C.J.; Arend, W.P.; Joslin, G.G.; Dripps, D.J.; Heimdal, P.L.; Armes, L.G.; Sommer, A.; Eisenberg, S.P.; Thompson, R.C., *Nature*, 1990, 343, 336-340; Eisenberg, S.P.; Evans, R.J.; Arend, W.P.; Verderber, E.; Brewer, M.T.; Hannum, C.H.; Thompson, R.C., *Nature*, 1990, 343, 341-346; Ohlsson, K.; Bjork, P.; Bergenfeldt, M.; Hageman, R.; Thompson, R.C., *Nature*, 1990, 348, 550-552; and Wakabayashi, G., *FASEB*, 1991, 338-343). The specific role of IL-1 β in inflammation and immunomodulation is supported by the recent observation that the cowpox virus employs an inhibitor of ICE to suppress the inflammatory response of its host (Ray, C.A. et al, *Cell*, 1992, 69, 597-604).

The present invention also relates to the modulation of processing of IL-1 β for the treatment of rheumatoid arthritis. Levels of IL-1 β are known to be elevated in the synovial fluid of patients with the disease. Additionally, IL-1 β stimulates the synthesis of enzymes believed to be involved in inflammation, such as collagenase and PLA₂, and produces joint destruction which is very similar to rheumatoid arthritis following intra-articular injection in animals.

ICE is believed to be a cysteine protease (Thornbury, N.A. et al, *Nature*, 1992, 356-768). Peptidyl methyl ketone analogs constitute a well-known class of compounds having cysteine protease inhibitory activity. (D. Rich in Chapter 4 of "Proteinase Inhibitors", Barrett, A.J. and Salvensen, G., eds., Elsevier, 1986). However, there has never been a reported example of a non-peptide heterocyclic inhibitor of a cysteine protease. Hence, the inhibitory activity displayed by the pyridazine analogs described herein against ICE is unique.

An effective therapy has yet to be developed for the treatment of IL-1 β mediated inflammatory diseases. Consequently, there is a need for therapeutic agents effective in the treatment and prevention of these diseases.

In accordance with the present invention, novel non-peptidic pyridazines are provided having the formula (I) and a pharmaceutically acceptable salt thereof



wherein

R₁ is halogen, oxygen linked leaving group including aromatic ether, aromatic ester, alkyl sulfonate, aryl sulfonate, alkyl phosphonate, aryl phosphonate, alkyl phosphate or aryl phosphate;

R₂ is OR₅, NH(CHR₅)_m-COOR₅, NH(CHR₅)_mCON(R₅)R₆, N(R₅)R₆ or NH(CHR₅)_nOH;

R₃ is H or alkyl;

R₄ is H, substituted or unsubstituted aryl, heteroaryl or alkyl;

R₅ and R₆ are independently H, lower alkyl, aryl, heteroaryl, aralkyl, heteroaralkyl or lower cycloalkyl;

m = 1-6; and

n = 2-6.

As used herein, the term pharmaceutically acceptable salts includes the acid and base addition salts.

The term acid addition salts refers to those salts which retain the biological effectiveness and properties of the free bases and which are not biologically or otherwise undesirable, formed with inorganic acids such as hydrochloric acid, hydrobromic acid, sulfuric acid, nitric acid, phosphoric acid and the like, and organic acids such as acetic acid, propionic acid, glycolic acid, pyruvic acid, oxalic acid, maleic acid, malonic acid, succinic acid, fumaric acid, tartaric acid, citric acid, benzoic acid, cinnamic acid, mandelic acid, methanesulfonic acid, ethanesulfonic acid, p-toluenesulfonic acid, salicylic acid and the like.

The term base addition salts include those derived from inorganic bases such as sodium, potassium, lithium, ammonium, calcium, magnesium, iron, zinc, copper, manganese, aluminum salts and the like. Particularly preferred are the ammonium, potassium, sodium, calcium and magnesium salts derived from pharmaceutically acceptable organic non-toxic bases which include salts of primary, secondary, and tertiary amines, substituted amines including naturally occurring substituted amines, cyclic amines and basic ion exchange resins, such as isopropylamine, trimethylamine, diethylamine, triethylamine, tripropylamine, ethanolamine, 2-dimethylaminoethanol, 2-diethylaminoethanol, trimethylamine, dicyclohexylamine, lysine, arginine, histidine, caffeine, procaines, hydrabamine, choline, betaine, ethylenediamine, glucosamine, methylglucamine, theobromine, purines, piperazine, piperidine, N-ethylpiperidine, polyamine resins and the like. Particularly preferred organic non-toxic bases are isopropylamine, diethylamine, ethanolamine, trimethylamine, dicyclohexylamine, choline and caffeine.

Alkyl is defined as a saturated or unsaturated aliphatic hydrocarbon which may be either straight- or branched-chain. Preferred groups have no more than about 12 carbon atoms and may be methyl, ethyl and structural isomers of propyl, butyl, pentyl, hexyl, heptyl, octyl, nonyl, decyl, undecyl and dodecyl.

Lower alkyl is defined as an alkyl group as above, having 1 to 8 carbon atoms. Suitable lower alkyl groups are methyl, ethyl, n-propyl, isopropyl, butyl, tert-butyl, n-pentyl, neopentyl, n-hexyl, and n-heptyl.

Lower cycloalkyl is defined as a carbocyclic ring of 3-8 carbon atoms including cyclopropyl, cyclobutyl, cyclopentyl and cyclohexyl.

Aryl is defined as phenyl, naphthyl and substituted phenyl.

Substituted phenyl is defined as a phenyl group in which one or more of the hydrogens has been replaced by the the same or different substituents including halo, lower alkyl, nitro, amino, cyano, acylamino, hydroxyl, lower alkoxy, aryl, heteroaryl, alkylsulfonyl, arylsulfonamido, trifluoromethyl, morpholinoethoxy, morpholinosulfonyl, and carbobenzoxyethylsulfamoyl.

Halogen is defined as chloride, fluoride, bromide or iodide.

Heteroaryl is defined as pyridyl, thienyl, furyl, thiazolyl, imidazolyl, pyrazolyl, triazinyl, quinolyl and isoquinolyl.

Substituted heteroaryl means a heteroaryl group in which one or more of the hydrogens has been replaced by the the same or different substituents including halo, lower alkyl, nitro, amino, acylamino, hydroxyl, lower alkoxy, aryl, heteroaryl, alkylsulfonyl, trifluoromethyl, morpholinoethoxy, morpholinosulfonyl and carbobenzoxyethylsulfamoyl.

Aralkyl is defined as an alkyl group substituted by an aryl ring, e.g. benzyl, phenethyl and 4-chlorobenzyl.

The present invention also concerns a method of inhibiting interleukin-1 β protease activity in a mammal in need of such treatment comprising administering to said mammal an effective inhibitory amount of a compound of formula (I) or a pharmaceutical composition containing a compound of the formula (I) in a pharmaceutically acceptable carrier. The method of inhibition is directed for the treatment of IL-1 β mediated disease states or disorders which include: infectious diseases, such as meningitis and salpingitis; septic shock, respiratory diseases; inflammatory conditions, such as arthritis, cholangitis, colitis, encephalitis, endocervicitis, hepatitis, pancreatitis and reperfusion injury, immune-based diseases, such as hypersensitivity; auto-immune diseases, such as multiple sclerosis; bone diseases; and certain tumors.

The pharmaceutical composition of the present invention comprises an active ingredient of the compound of formula (I) in admixture with a pharmaceutically acceptable, non-toxic carrier. Such compositions may be prepared for use by any of a variety of routes depending upon the specific end use, including parenterally (including subcutaneous, intra-articular, intramuscular and intravenous administration), particularly in the form of liquid solutions or suspensions; for oral or buccal (including sublingual) administration, particularly in the form of tablets or capsules; intranasally, particularly in the form of powders, nasal drops or aerosols, or transdermally. The most suitable route in any given case will depend upon the use, the particular active ingredient, and the subject involved. The compound or composition may also be administered by means of controlled-release, depot implant or injectable formulations as described more fully herein.

When administered orally (or rectally) the compounds will usually be formulated into a unit dosage form such as a tablet, capsule, suppository or cachet. Such formulations typically include a solid, semi-solid or liquid carrier or diluent. Exemplary diluents and vehicles are lactose, dextrose, sucrose, sorbitol, mannitol, starches, gum acacia, calcium phosphate, mineral oil, cocoa butter, oil of theobroma, alginates, tragacanth, gelatin, syrup, methylcellulose, polyoxyethylene sorbitan monolaurate, methyl hydroxybenzoate, propyl hydroxybenzoate, talc, and magnesium stearate.

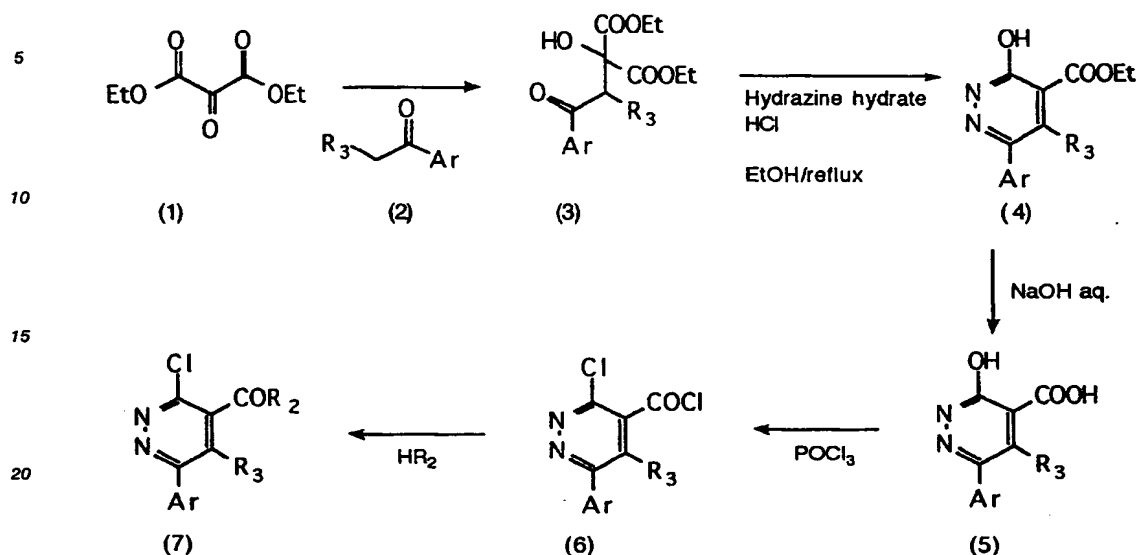
The compositions may be prepared by any of the methods well-known in the pharmaceutical art, for example as described in Remington's Pharmaceutical Sciences, 17th edition, Mack Publishing Company, Easton, PA, 1985. Formulations for parenteral administration may contain as common excipients sterile water or saline, alkylene glycols such as propylene glycol, polyalkylene glycols such as polyethylene glycol, oils of vegetable origin, hydrogenated naphthalenes and the like. Examples of vehicles for parenteral administration include water, aqueous vehicles such as saline, Ringer's solution, dextrose solution, and Hank's solution and nonaqueous vehicles such as fixed oils (such as corn, cottonseed, peanut, and sesame), ethyl oleate, and isopropyl myristate. Sterile saline is a preferred vehicle and the compounds are sufficiently water soluble to be made up as a solution for all foreseeable needs. The vehicle may contain minor amounts of additives such as substances that enhance solubility, isotonicity, and chemical stability, for example, antioxidants, buffers, and preservatives. For oral administration, the formula can be enhanced by the addition of bile salts and also by the addition of acylcarnitines (Am. J. Physiol. 251:332 (1986)). Formulations for nasal administration may be solid and contain as excipients, for example, lactose or dextran, or may be aqueous or oily solutions for administration in the form of nasal drops or metered spray. For buccal administration typical excipients include sugars, calcium stearate, magnesium stearate, pregelatinated starch, and the like.

When formulated for nasal administration the absorption across the nasal mucous membrane is enhanced by surfactant acids, such as for example, glycocholic acid, cholic acid, taurocholic acid, ethocholic acid, desoxycholic acid, chenodesoxycholic acid, dehydrocholic acid, glycodeoxycholic acid, and the like (See, B.H. Vickery, "LHRH and its Analogs-Contraception and Therapeutic Applications", Pt. 2, B.H. Vickery and J.S. Nester, Eds., MTP Press, Lancaster, UK, 1987).

In general, for the uses as described in the present invention, it is expedient to administer the active ingredient in amounts between about 0.1 and 100 mg/kg body weight, most preferably from about 0.1 to 30 mg/kg body weight for human therapy, the active ingredient being administered preferably in the range of from about 0.1 to about 20-50 mg/kg/day. This administration may be accomplished by a single administration, by distribution over several applications or by slow release in order to achieve the most effective results. When administered as a single dose, administration will most preferably be in the range of from about 0.1 to mg/kg to about 10 mg/kg.

The exact dose and regimen for administration of these compounds and compositions will necessarily be dependent upon the needs of the individual subject being treated, the type of treatment, and the degree of affliction or need. In general, parenteral administration requires lower dosage than other methods of administration which are more dependent upon absorption.

Compounds of the present invention are prepared according to Schemes I, II and III.

Scheme I

wherein

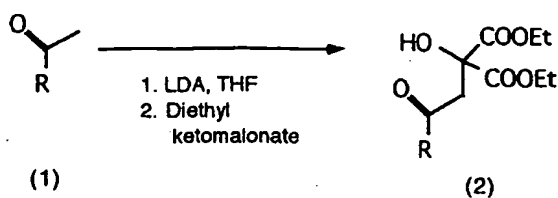
R₂ and R₃ are defined previously.

Referring to Scheme I, typified by R₄ = aryl and R₁ = Cl, the condensation of α-keto esters with aryl ketones to provide 6-aryl-3-hydroxypyridazines has been previously described [Druey, J. and von Schmidt, P. (1954) *Helv. Chim. Acta.*, Vol. 37, 134]. Diethyl ketomalonate (1) and the aryl ketone (2) are heated together neat to approximately 120°C for 15 hours to provide the condensation product (3). The keto-diester (3) is then treated with hydrazine in ethanol at reflux to form the 6-aryl-3-hydroxy-pyridazine (4), as crystalline solids. Saponification with aqueous alkali followed by neutralization provides the 3-hydroxy-4-carboxy-6-aryl-pyridazines (5). The conversion of 3-hydroxy-4-carboxy-6-aryl-pyridazines to their dichlorides (6) has been previously described in U.S. Patent No. 4,590,194 and is performed by heating the pyridazines (5) with a halogenating agent (phosphorus oxychloride being the preferred agent) at reflux temperature (80°C) for 4 hours. The halogenating agent may be used neat or with inert solvent such as dioxane or toluene. The addition of a catalytic amount of DMF accelerates the reaction. Other suitable halogenating agents include phenylphosphinic dichloride and phosphorus trichloride.

The corresponding 3-bromopyridazines are prepared similarly by heating (5) with phosphorous oxybromide or phosphorus tribromide. The dichlorides (6) are isolated from the reaction mixture by removing excess halogenating agent and solvent *in vacuo* and redissolving the residue in hot acetonitrile or other polar inert solvent. The reaction of the dichlorides (6) in acetonitrile with alcohols or amines yield the desired esters or amides (7).

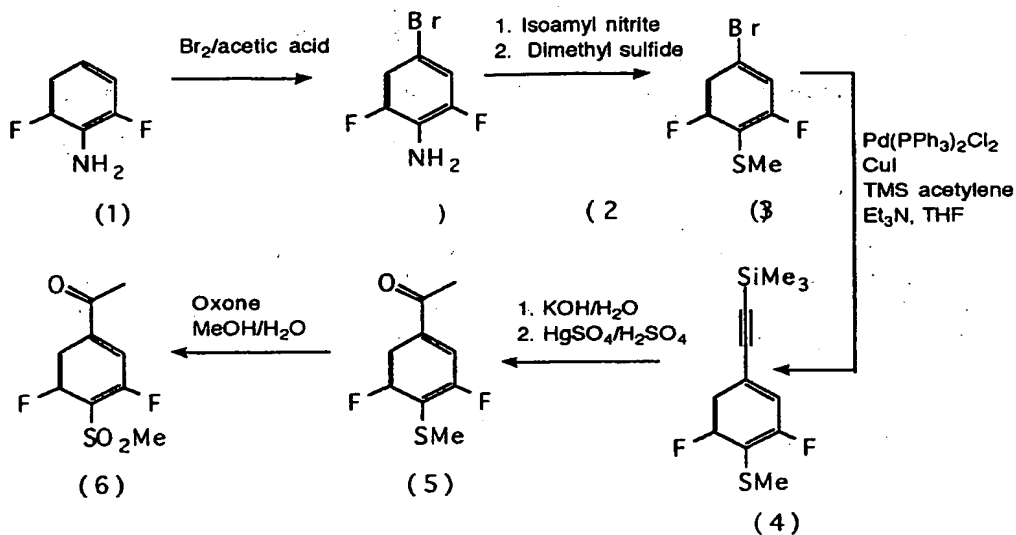
Referring to Scheme II, intermediate ketomalonate addition products (2) can be prepared by deprotonation of the acetophenones (1) with lithium diisopropylamine (LDA) followed by the addition of ketomalonate. This procedure was generally used for electron-rich aryl methyl ketones.

Scheme II



wherein R is phenyl, substituted aryl or heteroaryl.

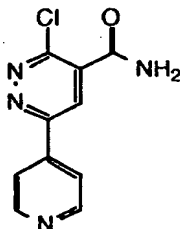
Scheme III



Referring to Scheme III, the intermediate 3,5-difluoro-4-(methylsulfonyl)acetophenone (6), used in Example 19, was prepared from commercially available 2,6-difluoroaniline. Bromination of the aniline (1) in acetic acid followed by diazotization and treatment of the diazonium salt with dimethylsulfide provides the thiomethyl derivative (3). Palladium catalyzed coupling reaction of (3) with trimethylsilylacetylene yield arylacetylene (4).

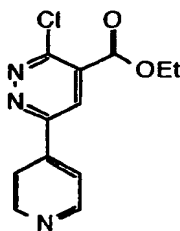
Alkaline hydrolysis of the silyl group followed by mercuration and acidic solvolysis affords ketone (5). Oxidation of the ketone with Oxone provides the desired 3,5-difluoro-4-(methylsulfonyl)acetophenone (6).

The following examples further illustrate the invention but are not to be construed as limiting of the specification and claims in any way.

EXAMPLE 1**3-Chloro-4-carboxamido-6-(4-pyridyl)pyridazine**

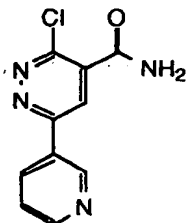
Diethyl ketomalonate (17.4 g, 0.1 mol) was heated with 4-acetylpyridine (12.1 g, 0.1 mol) at 120°C for 15 h under nitrogen to provide diethyl 2-hydroxy-2-(4-pyridyl)carbonylmethylmalonate as a crystalline solid. The diester was refluxed in ethanol with a slight excess of hydrazine hydrate hydrochloride for 15 h to provide 3-hydroxy-6-(4-pyridyl)-4-carbethoxypyridazine (4, Scheme 1). The above ester was recrystallized from ethanol, hydrolyzed with aqueous sodium hydroxide followed by careful neutralization with hydrochloric acid to afford 3-hydroxy-6-(4-pyridyl)pyridazine-4-carboxylic acid (5, Scheme 1). The acid was dissolved in phosphorous oxychloride containing a catalytic amount of DMF and the mixture was allowed to react at 80°C for 4 h to provide 3-chloro-4-chlorocarbonyl-6-(4-pyridyl)pyridazine (6, Scheme 1) as a dark oil. The above dichloride was treated with gaseous ammonia in acetonitrile to afford the title compound as a tan solid. The above dichloride was treated with excess gaseous ammonia to afford the title compound as a tan solid: ¹H NMR (DMSO-d₆) δ 8.80 (d, J = 6 Hz, 2H), 8.59 (s, 1H), 8.20 (s, 1H), 8.17 (d, 6 Hz, 1 H).

Utilizing appropriate starting materials and respects, and following the procedures described in the Schemes and Example 1, the following compounds were prepared.

EXAMPLE 2**3-Chloro-4-carboethoxy-6-(4-pyridyl)pyridazine**

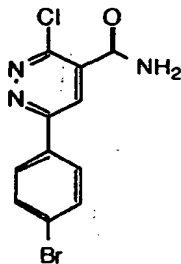
The title compound was prepared by treating pyridazine dichloride with anhydrous ethanol and a slight excess of triethylamine. The title compound was purified via silica gel chromatography (20% ethyl acetate/hexane).

Anal. for C ₁₂ H ₁₀ ClN ₃ O ₂ :			
Calcd.	C, 54.66;	H, 3.82;	N, 15.94.
Found:	C, 54.07;	H, 3.80;	N, 15.83.

EXAMPLE 3**3-Chloro-4-carboxamido-6-(3-pyridyl)pyridazine**

The title compound was prepared from 3-acetylpyridine.

Anal. for $C_{10}H_7ClN_4O_2$:			
Calcd.	C, 51.18;	H, 3.09;	N, 23.88.
Found:	C, 51.11;	H, 3.09;	N, 23.98.

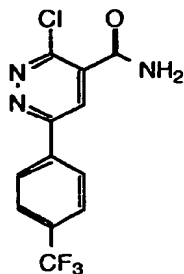
EXAMPLE 4**3-Chloro-4-carboxamido-6-(4-bromophenyl)pyridazine**

The title compound was prepared from 4-bromoacetophenone.

Anal. for $C_{11}H_7ClN_3O$:			
Calcd.	C, 42.27;	H, 2.26;	N, 14.44.
Found:	C, 42.24;	H, 2.19;	N, 13.34.

EXAMPLE 5

3-Chloro-4-carboxamido-6-(4-trifluoromethylphenyl)pyridazine

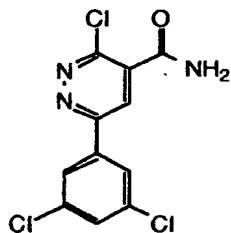


The title compound was prepared from 4-trifluoromethylacetophenone.

Anal. for $C_{12}H_7ClF_3N_3O$:			
Calcd.	C, 47.78;	H, 2.34;	N, 13.92.
Found:	C, 48.13;	H, 2.14;	N, 13.88.

EXAMPLE 6

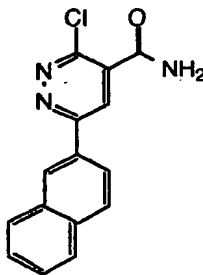
3-Chloro-4-carboxamido-6-(3,5-dichlorophenyl)pyridazine



The title compound was prepared from 3,5-dichloroacetophenone. DCI-MS m/z 301.

EXAMPLE 7

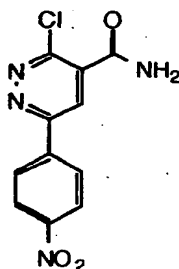
3-Chloro-4-carboxamido-6-(2-naphthyl)pyridazine.



The title compound was prepared from 2-acetonaphthone. DCI-MS m/z 283 (M^+).

EXAMPLE 8

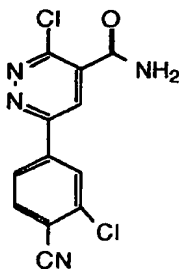
3-Chloro-4-carboxamido-6-(4-nitrophenyl)pyridazine



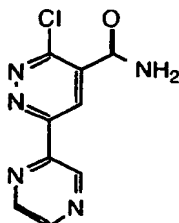
The title compound was prepared from 4-nitroacetophenone. FAB-MS m/z 279 ($M + H^+$)

EXAMPLE 9

3-Chloro-4-carboxamido-6-(3-chloro-4-cyanophenyl)pyridazine



The title compound was prepared from 3-chloro-4-cyanoacetophenone. DCI-MS m/z 292.

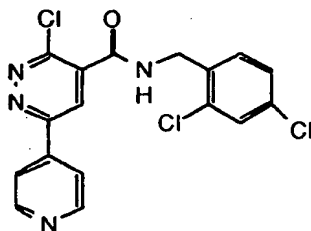
EXAMPLE 103-Chloro-4-carboxamido-6-(2-pyrazyl)pyridazine

The title compound was prepared from 2-acetylpyrazine. DCI-MS m/z 236 ($M + H$).

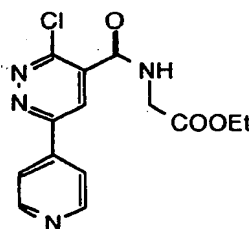
EXAMPLE 113-Chloro-4-carboxamido-5-methyl-6-(4-chlorophenyl)pyridazine

The title compound was prepared from 4-chloropropiophenone. DCI-MS m/z 282 ($m + H +$). 1H NMR (MeOD) δ 7.33 (s, 4H), 2.12 (s, 3H).

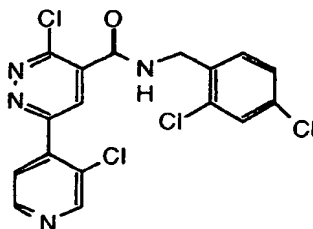
Anal. for $C_{12}H_5Cl_2N_3O$:			
Calcd.	C, 51.09;	H, 3.22;	N, 14.89.
Found:	C, 50.98;	H, 3.34;	N, 14.48.

EXAMPLE 12**3-Chloro-4-(2,4-dichlorobenzylaminocarbonyl)-6-(4-pyridyl)pyridazine**

The title compound was prepared by treating the dichloride (6) with 2,4-dichlorobenzylamine according to Scheme I. DCI-MS m/z 392 ($m + H^+$). 1H NMR ($CDCl_3$) δ 8.83 (d, $J=6$ Hz, 2H), 8.33 (a, 1H), 8.00 (d, $J=6$ Hz, 2H), 7.5 (m, 2H), 7.3 (m, 3H), 4.76 (d, $J=6$ Hz, 2H).

EXAMPLE 13**3-Chloro-4-[(C-ethoxy)glycyl]carbonyl)-6-(4-pyridyl)pyridazine**

The title compound was prepared by treating the dichloride (6) with glycyl-ethyl ester according to Scheme I. DCI-MS m/z 320 ($M + H$). 1H NMR ($DMSO-d_6$) δ 8.80 (d, $J=6$ Hz, 2H), 8.52 (s, 1H), 8.16 (d, $J=6$ Hz, 2H), 4.13 (m, 4H), 1.22 (t, $J=7.1$ Hz, m, 3H).

EXAMPLE 14**3-Chloro-4-(2,4-dichlorobenzylaminocarbonyl)-6-[4-(3-chloro)pyridyl]pyridazine**

The title compound was prepared by reacting the dichloride (6) with 2,4-dichlorobenzylamine according to Scheme I.

Anal. for C ₁₇ H ₁₀ Cl ₄ N ₄ O:			
Calcd.	C, 47.7;	H, 2.35;	N, 13.09.
Found:	C, 47.61;	H, 2.25;	N, 13.06.

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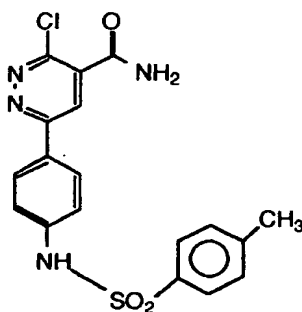
EXAMPLE 15

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3-Chloro-4-carboxamido-6-[4-(p-toluenesulfonamido)phenyl]pyridazine

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The title compound was prepared via catalytic hydrogenation of the p-nitrophenyl analog (5) of pyridazine followed by toluenesulfonylation and steps 4 - 5 according to Scheme I. DCI-MS m/z 402 (M⁺), 403 (M⁺ + H).

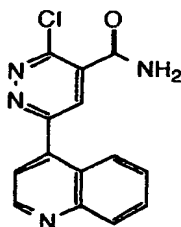
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EXAMPLE 16

3-Chloro-4-carboxamido-6-(4-quinolyl)pyridazine

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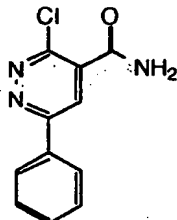
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The title compound was prepared from 4-acetylquinoline. ¹H NMR (MeOD) δ 4.65 (s, 3H), 7.45 (m, 2H), δ 8.80 (d, J = 6 Hz, 2H), 7.64 (m, 1H), 7.85 (d, J = 8.5 Hz, 1H), 7.93 (d, J = 8.8 Hz, 1H), 7.96 (s, 1H), 8.79 (d, J = 4.45 Hz, 1H).

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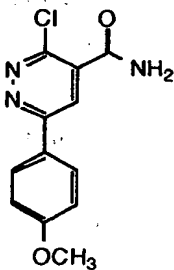
The intermediate 4-acetylquinoline was prepared by treatment of commercially available 4-quinolinecarboxaldehyde with methyl-magnesium chloride in ether followed by oxidation of the resulting secondary alcohol with manganese dioxide.

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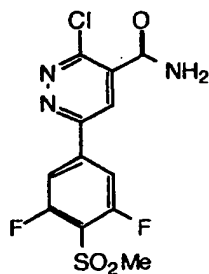
EXAMPLE 17**3-Chloro-4-carboxamido-6-(phenyl)pyridazine**

A solution of acetophenone in THF at -70°C was treated with a solution of lithium diisopropylamide in THF (Scheme II). After 15 min diethyl ketomalonate was added and the reaction was allowed to warm to room temperature. The resulting condensation product 2 (Scheme II) was used following the procedure of Scheme I.

DCI-MS m/z 233 (M^+), 234 ($M + H$).

EXAMPLE 18**3-Chloro-4-carboxamido-6-(4-methoxyphenyl)pyridazine**

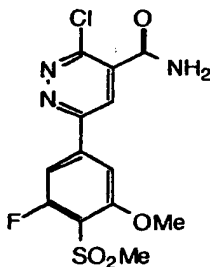
The title compound was prepared from p-methoxyacetophenone in a manner analogous to Example 17. DCI-MS m/z 263 (M^+), 264 ($M + H$).

EXAMPLE 193-Chloro-4-carboxamido-6-[3,5-difluoro-4(methylsulfonyl)phenyl]pyridazine

The title compound was prepared from 3,5-difluoro-4-(methylsulfonyl)acetophenone according to Scheme I.

Anal. for $C_{12}H_8ClF_2N_3O_3$:			
Calcd.	C, 41.45;	H, 2.32;	N, 12.08.
Found:	C, 41.19;	H, 32.26;	N, 12.03.

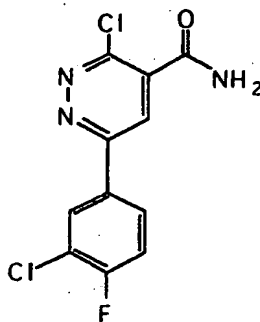
The intermediate 3,5-difluoro-4-(methylsulfonyl)acetophenone was prepared from commercially available 2,6-difluoroaniline according to Scheme III.

EXAMPLE 203-Chloro-4-carboxamido-6-[3-fluoro-4(methylsulfonyl)-5-(methoxy)phenyl]pyridazine

The title compound was prepared by refluxing 3-chloro-4-carboxamido-6-[3,5-difluoro-4(methylsulfonyl)phenyl]pyridazine made in Example 19 in methanol. DCI-MS m/z 359 (M^+), 360 ($M + H$).

EXAMPLE 213-Chloro-4-[(phenylalanylcabamido)carbonyl]-6-(4-chlorophenyl)pyridazine

The title compound was prepared by treating the dichloride (6) with phenylalanine amide according to Scheme I.
DCI-MS m/z 414 (M^+), 415 ($M + H$).

EXAMPLE 22**3-Chloro-4-carboxamido-6-(3-chloro-4-fluorophenyl)pyridazine**

The title compound was prepared from 3-chloro-4-fluoroacetophenone. DCI-MS m/z 286 ($M + H^+$).

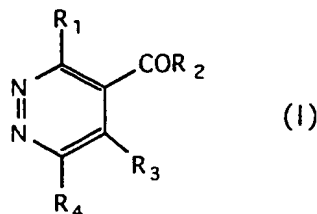
Compounds of the present invention were tested for IL-1 β protease inhibition activity according to the following protocol:

Partially purified IL-1 β protease is stored at -80°C , thawed on ice, and preincubated for 10 minutes at 37°C with 2.5 mM dithiothreitol in a buffer solution containing 10 mM Tris-HCl (pH 8.0) and 25% (v/v) glycerol. Inhibitors are prepared as stock solutions in dimethyl sulfoxide (DMSO). The protease is preincubated with inhibitor in a volume of 20 μl in a 1.5 ml polypropylene microcentrifuge tube for 15 minutes at 37°C . The volume of compound added to the assay is adjusted to yield a DMSO concentration in the preincubation of <15% (v/v). The enzyme assay is then initiated by the addition of substrate (TRITC-AYVHDAPVRS-NH₂) to yield a final concentration of 67 μM in a final volume of 30 μl . The reactions are carried out for 60 minutes at 37°C in the dark and are terminated by the addition of 10 μl 10% trifluoroacetic acid (TFA). Following the addition of 115 μl 0.1% TFA, the samples are analyzed by high pressure liquid chromatography using a reverse phase (C18) column and elution with an acetonitrile/water/TFA gradient. Substrate and product are monitored by their absorbance at 550 nm and elute at 4.2 and 5.2 minutes, respectively.

The IL-1 β protease inhibitory activity (IC_{50}) for the pyridazine was <100 μM .

Claims

1. A compound of the formula (I) or a pharmaceutically acceptable salt thereof:



wherein

R_1 is halogen, oxygen linked leaving group including aromatic ether, aromatic ester, alkyl sulfonate, aryl

sulfonate, alkyl phosphonate, aryl phosphonate, alkyl phosphate or aryl phosphate;

R_2 is OR_5 , $\text{NH}(\text{CHR}_5)_m\text{-COOR}_5$, $\text{NH}(\text{CHR}_5)_m\text{CON}(\text{R}_5)\text{R}_6$, $\text{N}(\text{R}_5)\text{R}_6$ or $\text{NH}(\text{CHR}_5)_n\text{OH}$;

R_3 is H or alkyl;

R_4 is H, substituted or unsubstituted aryl, heteroaryl or alkyl;

R₅ and R₆ are independently H, lower alkyl, aryl, heteroaryl, aralkyl, heteroaralkyl or lower cycloalkyl;
 m = 1-6; and
 n = 2-6.

2. A compound according to claim 1 wherein said aryl is phenyl, naphthyl or substituted phenyl.
- 5 3. A compound according to claim 1 wherein said phenyl is substituted by halo, lower alkyl, nitro, amino, cyano, acylamino, hydroxyl, lower alkoxy, trifluoromethyl, alkylsulfonyl, arylsulfonamido, morpholinoethoxy or morpholinosulfonyl.
4. A compound according to claim 1 wherein said heteroaryl is pyridyl, thienyl, furyl, thiazolyl, imidazolyl, pyrazolyl, triazinyl, quinolyl or isoquinolyl.
- 10 5. A compound according to claim 1 selected from the group consisting of: 3-Chloro-4-carboxamido-6-(4-pyridyl)pyridazine,
 3-Chloro-4-carboethoxy-6-(4-pyridyl)pyridazine,
 3-Chloro-4-carboxamido-6-(3-pyridyl)pyridazine,
 3-Chloro-4-carboxamido-6-(4-bromophenyl)pyridazine and
 3-Chloro-4-carboxamido-6-(4-trifluoromethylphenyl)pyridazine.
- 15 6. A compound according to claim 1 selected from the group consisting of: 3-Chloro-4-carboxamido-6-(3,5-dichlorophenyl)pyridazine,
 3-Chloro-4-carboxamido-6-(2-naphthyl)pyridazine,
 3-Chloro-4-carboxamido-6-(4-nitrophenyl)pyridazine,
 20 3-Chloro-4-carboxamido-6-(3-chloro-4-cyanophenyl)pyridazine and
 3-Chloro-4-carboxamido-6-(2-pyrazyl)pyridazine
7. A compound according to claim 1 selected from the group consisting of: 3-Chloro-4-carboxamido-5-methyl-6-(4-chlorophenyl)pyridazine,
 3-Chloro-4-(2,4-dichlorobenzylaminocarbonyl)-6-(4-pyridyl)pyridazine,
 25 3-Chloro-4-[(C-ethoxy)glycyl]carbonyl)-6-(4-pyridyl)pyridazine,
 3-Chloro-4-(2,4-dichlorobenzylaminocarbonyl)-6-[4-(3-chloro)pyridyl]pyridazine and
 3-Chloro-4-carboxamido-6-[4-(p-toluenesulfonamido)phenyl]pyridazine.
8. A compound according to claim 1 selected from the group consisting of: 3-Chloro-4-carboxamido-6-(4-quinolyl)pyridazine,
 30 3-Chloro-4-carboxamido-6-(phenyl)pyridazine,
 3-Chloro-4-carboxamido-6-(4-methoxyphenyl)pyridazine,
 3-Chloro-4-carboxamido-6-[3,5-difluoro-4(methylsulfonyl)phenyl]pyridazine,
 3-Chloro-4-carboxamido-6-[3-fluoro-4(methylsulfonyl)-5(methoxy)phenyl]pyridazine,
 3-Chloro-4[(phenylalanylcarbonyl)-6-(4-chlorophenyl)pyridazine and
 35 3-Chloro-4-carboxamido-6-(3-chloro-4-fluorophenyl)pyridazine.
7. A pharmaceutical composition for inhibiting interleukin-1 β protease comprising a compound of the formula (I) or a pharmaceutically acceptable salt thereof according to any one of the preceding claims in a pharmaceutically acceptable carrier.
8. The use of a compound of formula (I) or a pharmaceutically acceptable salt thereof according to any one
 40 of claims 1 to 6 or a pharmaceutical composition according to claim 7 for the preparation of a medicament for inhibiting interleukin-1 β protease activity in a mammal in need of such treatment.

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